

Attorney's Docket No. 38190/267789

**PATENT**

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Inventor: Edward Litwinski, Rahmatollah F. Toosky  
Appl. No.: 10/631,906  
Filed: July 31, 2003  
For: METHOD OF MANUFACTURING  
RIVETS HAVING HIGH STRENGTH  
AND FORMABILITY

Confirmation No.: 9631  
Group Art Unit: 1725  
Examiner: Lynne Renee Edmondson

August 18, 2004

Commissioner for Patents  
P.O. Box 1450  
Alexandria, Virginia 22313-1450

**DECLARATION UNDER 37 C.F.R. § 1.131**

Sir:


We, Edward Litwinski and Rahmatollah F. Toosky, hereby declare and state that:

1. We are the inventors of the claimed invention of the above-identified U.S. Patent Application Serial No. 10/631,906.
2. On or before October 23, 2001, we had reduced to practice our invention as described and claimed in the subject application, generally directed to a method of manufacturing rivets having high strength and formability. Attached as Exhibit A is a copy of a data summary sheet and four graphs as evidence of our reduction to practice before October 23, 2001. Each of the four graphs illustrates stress versus strain characteristics of two specimens prepared according to the present invention, and the data summary sheet includes the test results for all of the eight specimens. The test specimens were produced by (a) providing a plate of aluminum alloy, (b) friction stir welding a portion of the plate to form a refined grain structure in the portion of the plate, (c) cutting a strip-shaped blank from the refined portion of the plate, (d) machining the blank to form a cylindrical rod, and (d) cutting the rod at successive increments along its length to form

In re: Edward Litwinski, et al.  
Appl. No.: 10/631,906  
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Page 2 of 2

a plurality of cylindrical specimens. During testing, each specimen was loaded into a fixture defining a cylindrical orifice such that a portion of the specimen extended from the orifice. The extending portion was then compressed toward the fixture, thereby deforming the extending portion to form a head having a diameter greater than the rest of the specimen. A copy of the deformed specimens appears on each graph of the shear test results. (The deformed specimens are disposed in the orifices of the fixtures.) Each of the tests was conducted prior to October 23, 2001, and the four graphs were also prepared before that date. Color photographs of the same specimens are included in Appendix B. The color photographs were taken after October 23, 2001. The test results are also described on page 3 of the invention disclosure, which is attached as Exhibit C. The invention disclosure was prepared and witnessed prior to October 23, 2001. Dates, personal information, and other information not relevant to the substantiation of invention have been redacted from the copies included in Appendices A and C.

3. We hereby declare that all statements made herein of our own knowledge are true, and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application of any patent issued thereon.

  
Edward Litwinski

\_\_\_\_\_  
Rahmatollah F. Toosky

CLT01/4659426v1

a plurality of cylindrical specimens. During testing, each specimen was loaded into a fixture defining a cylindrical orifice such that a portion of the specimen extended from the orifice. The extending portion was then compressed toward the fixture, thereby deforming the extending portion to form a head having a diameter greater than the rest of the specimen. A copy of the deformed specimens appears on each graph of the shear test results. (The deformed specimens are disposed in the orifices of the fixtures.) Each of the tests was conducted prior to October 23, 2001, and the four graphs were also prepared before that date. Color photographs of the same specimens are included in Appendix B. The color photographs were taken after October 23, 2001. The test results are also described on page 3 of the invention disclosure, which is attached as Exhibit C. The invention disclosure was prepared and witnessed prior to October 23, 2001. Dates, personal information, and other information not relevant to the substantiation of invention have been redacted from the copies included in Appendices A and C.

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Edward Litwinski

  
Rahmatollah F. Toosky

CLT01/4659426v1

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To: Ed Litwinski  
Rahmat F. Toosky

Mail: [REDACTED]

Subject: Boeing Invention Disclosure No. [REDACTED] "Highly Deformable, High Strength Rivet Material"

\*\*\*\*\*PERSONAL INFORMATION\*\*\*\*\*

Full Name: RAHMATOLLAH F. TOOSKY

Social Security Number: [REDACTED] Orgn \_\_\_\_\_ M/S \_\_\_\_\_

Work Phone: [REDACTED] Home Phone: [REDACTED]

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State: [REDACTED] Zip Code: [REDACTED]

Country: [REDACTED] Citizenship: [REDACTED]

Mailing Address:  
(if different) \_\_\_\_\_

Employee Type: Salaried: \_\_\_\_\_ Hourly: \_\_\_\_\_ Non-Boeing [REDACTED]

Company (if Non-Boeing) \_\_\_\_\_

\*\*\*\*\*ADDITIONAL INFORMATION (if known and appropriate)\*\*\*\*\*

1. Actual or projected date of first use by Boeing or others:  
\_\_\_\_\_
2. Actual or projected date of publication (outside of Boeing) of concepts or other information relating to the invention:  
\_\_\_\_\_

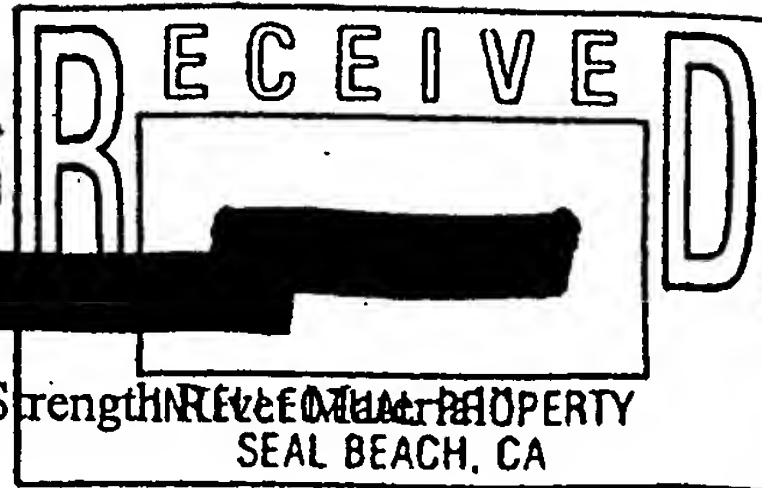
3. Useful descriptive materials (documents, drawings, test results, etc.);

See Attachments of Test DATA

\_\_\_\_\_ Copy included \_\_\_\_\_ Will furnish upon request

[REDACTED] (Date) Rahmat Toosky (Signature)

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To: Ed Litwinski  
Rahmat F. Toosky

Mail: [REDACTED]

Subject: Boeing Invention Disclosure No. [REDACTED] "Highly Deformable, High Strength [REDACTED] Material"

\*\*\*\*\*PERSONAL INFORMATION\*\*\*\*\*

Full Name: Edward Litwinski

Social Security Number: [REDACTED] Orgn [REDACTED] M/S [REDACTED]

Work Phone: [REDACTED] Home Phone: [REDACTED]

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City: [REDACTED] County: [REDACTED]

State: [REDACTED] Zip Code: [REDACTED]

Country: [REDACTED] Citizenship: [REDACTED]

Mailing Address: [REDACTED]  
(if different)

Employee Type: Salaried Hourly: \_\_\_\_\_ Non-Boeing \_\_\_\_\_

Company (if Non-Boeing) \_\_\_\_\_

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[REDACTED]

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3. Useful descriptive materials (documents, drawings, test results, etc.);

see attachments

\_\_\_\_ Copy included

\_\_\_\_ Will furnish upon request

[REDACTED]  
(Date)

Edward Litwinski  
(Signature)

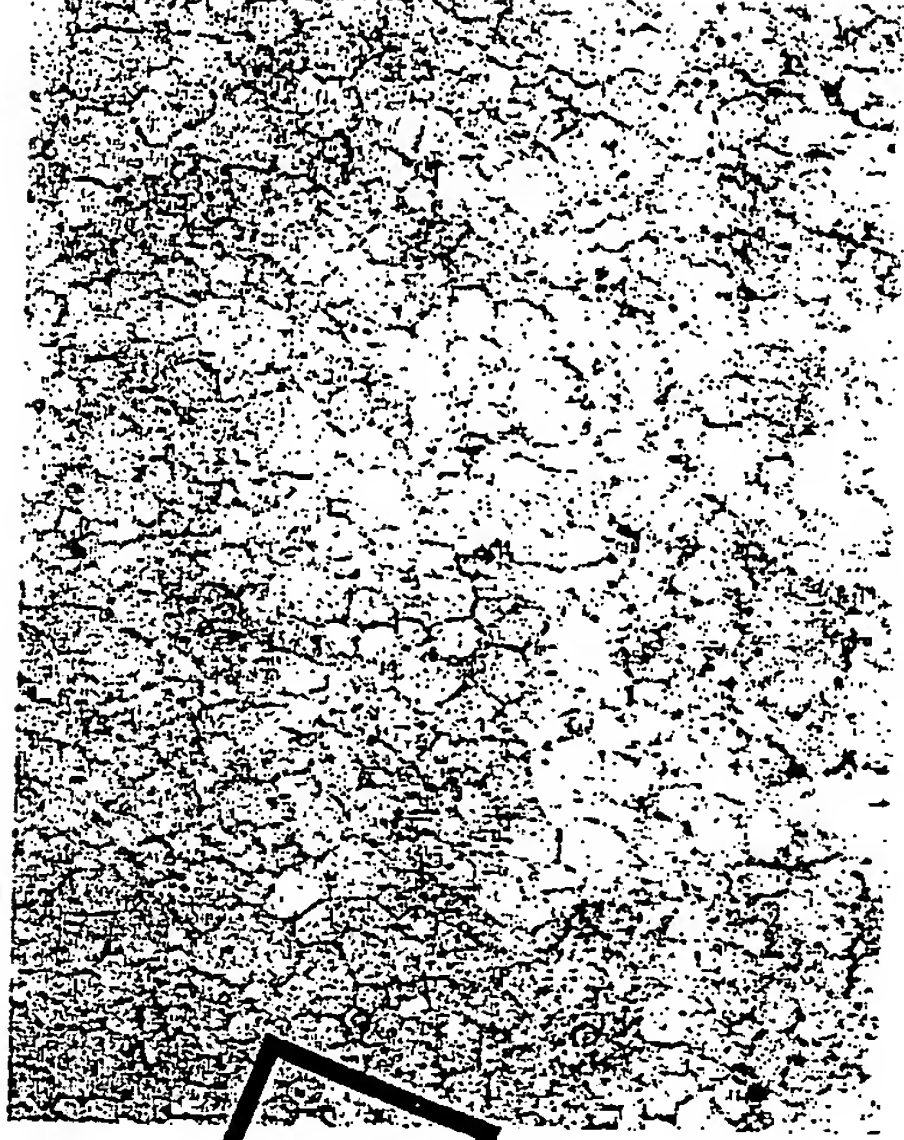
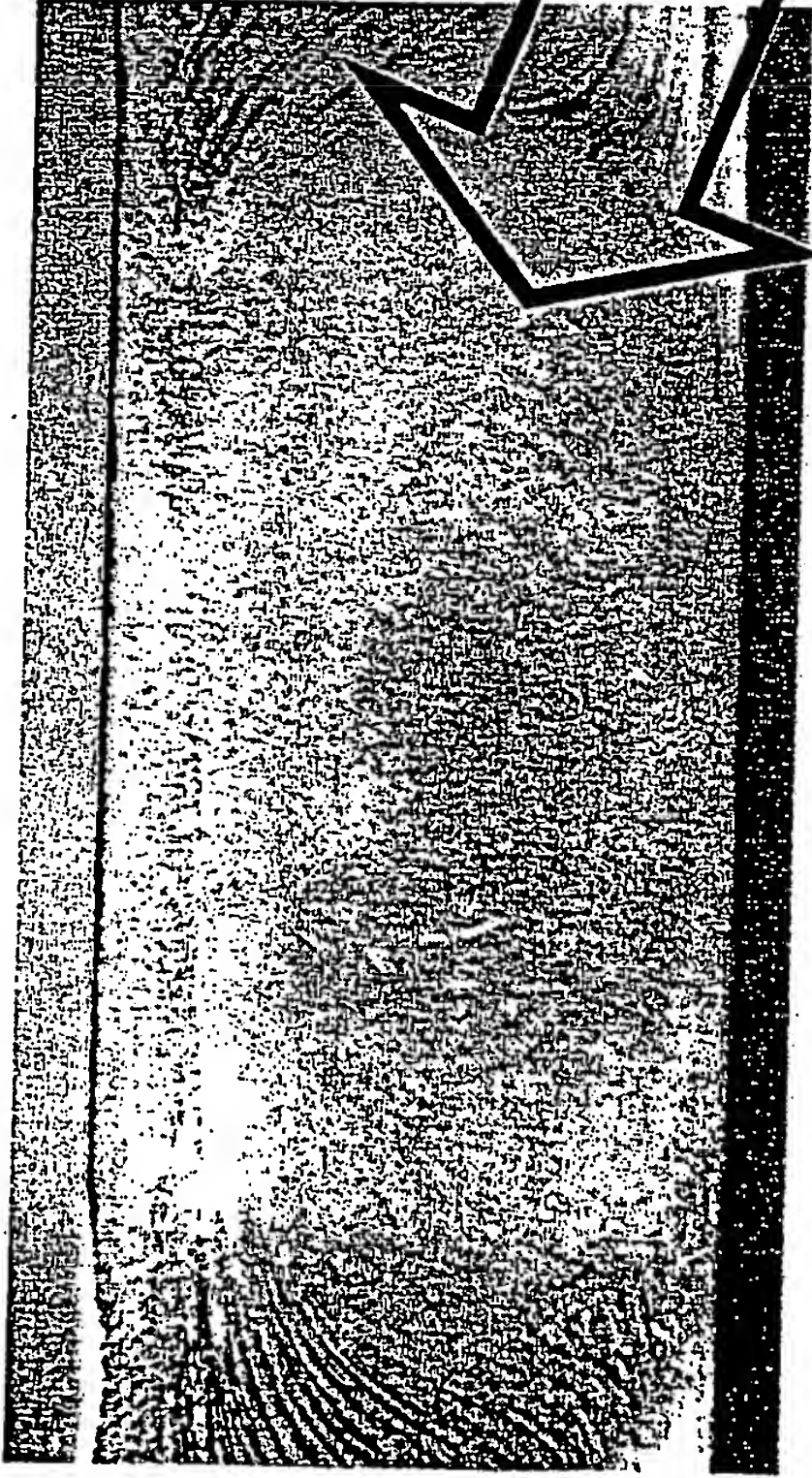
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# *Highly Deformable, High Strength Rivets*

## *The nugget of a FSW has a very fine grain structure*

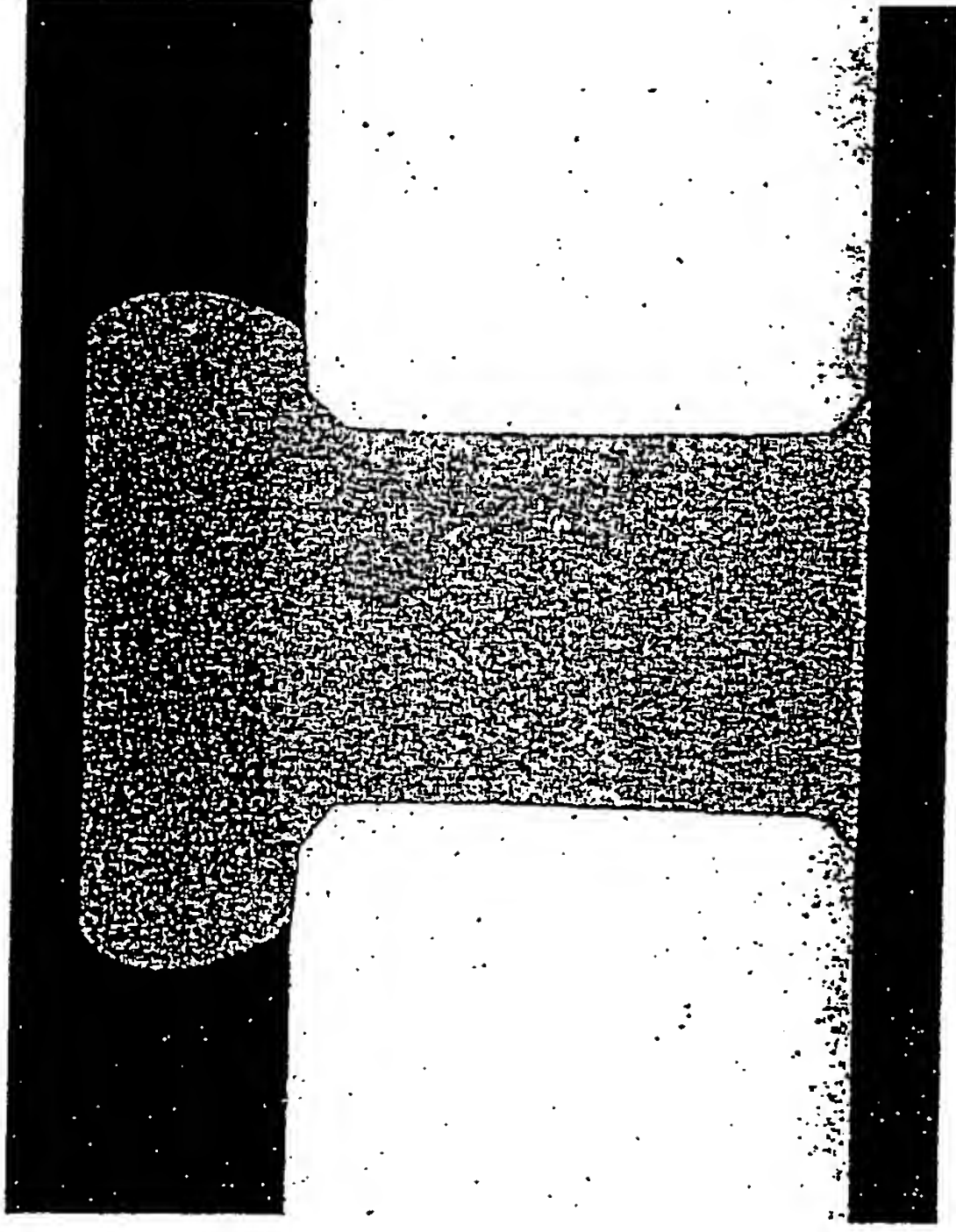


Fine grain size is known to increase toughness, fatigue strength and corrosion resistance.



# Conventional Rivet Technology

- Rivet materials had been chosen due to their ability to “upset” without cracking. The 2117-T4 alloy has been the conventional rivet alloy of choice.
- The increase in its ability to upset is related to its lack of strength



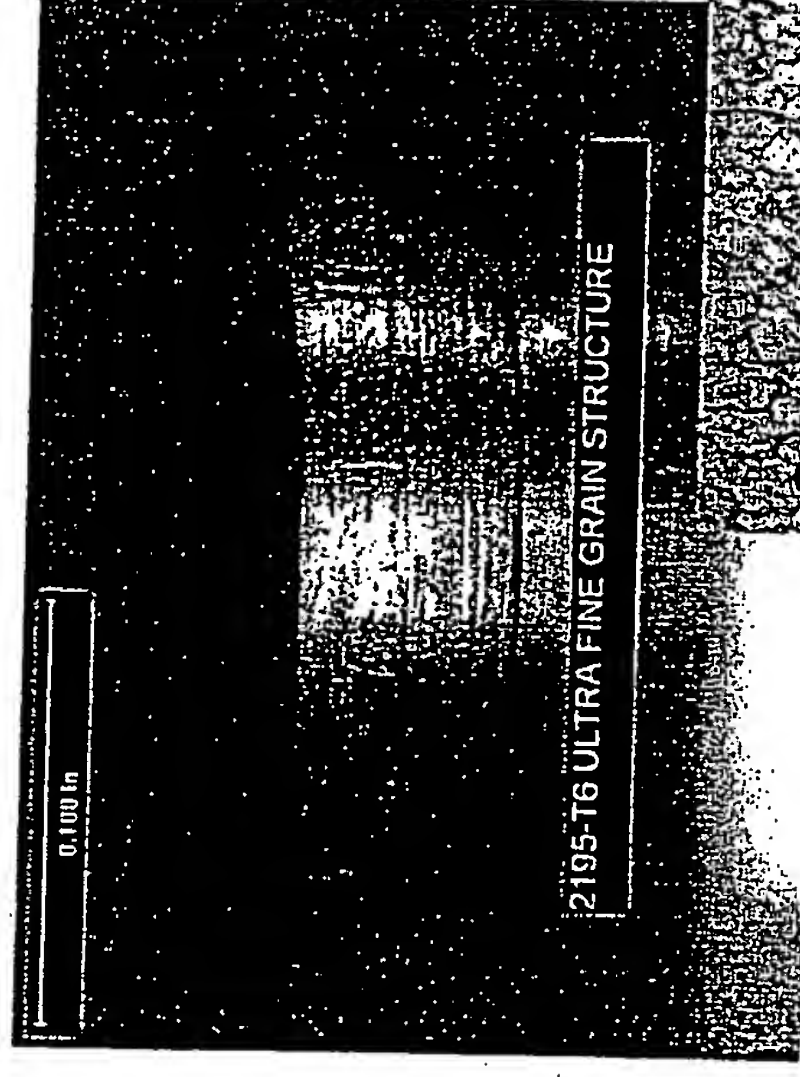
2117-T4 Material

# Conventional Al-Li Alloys

- Al-Li alloys are high strength alloys with reduced weight (approximately 4.5% less). However, the higher strength does not allow the alloy to “upset” without cracking.
- The fine grain FSW nugget material can upset without cracking.



2195-T6 Material



2195-T6 (FSW) Material





# Traditional Rivet Alloy Properties

- The 2195-T6 (FSW) material has better properties than conventional rivet materials.
- The process was not optimized. It is expected that with process improvements the properties could be improved to exceed conventional alloy properties with improved “upset”, toughness, fatigue and corrosion properties.

Alloy Data Summary

Alloy	Weight, lbs/in <sup>3</sup>	Ult. Tensile, ksi	Yield Strength, ksi	%Elongation	Shear, ksi
2195-T6 (FSW)	0.097	Not Available	Not Available	Not Available	38-41
2195-T6	0.097	73	66	10	45
2017-T4	0.101	62	40	22	38
2117-T4	0.099	43	24	27	28
7050-T7	0.102	74	65	13	41
7075-T7	0.101	73	63	13	37

**MECHANICAL PROPERTIES TESTING  
LABORATORY.**

DATE

**OF**

T - CHARGE	
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**MATERIAL**

SEE TABLE

SUBMITTER

K. TUCKY

TEST RATE

TESTING MACHINE

## INSTRUMENTATION

NOTE

**TECHNICIANS: PREPARED BY**

**TESTED BY**

**CALCULATED BY**

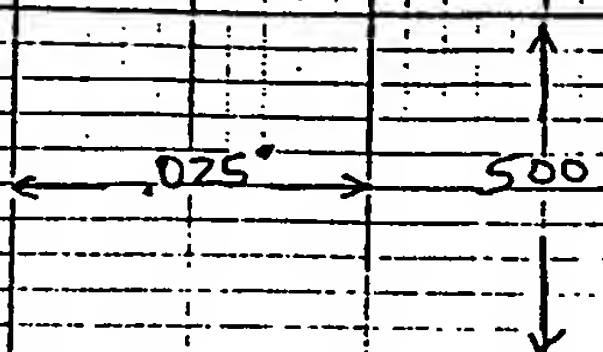
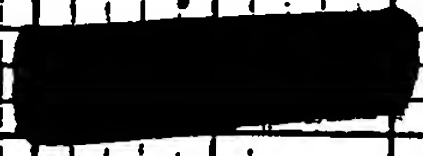
NO.	CODE	DIA. INCH	MULT. OBL. SHEAR LOAD (lb.)	SHEAR STRESS PSI
1	2219-T6	0.1555	1103	28040
2	"	0.1570	1105	28539
3	2195-T4	0.1555	1320	34755
4	"	0.1555	1439	37886
5	2195-T6	0.1575	1485	38599
6	"	0.1555	1559	41046
7	2219-T4	0.1570	1132	29155
8	"	0.1575	1160	29770

DATE

DATE [REDACTED]

2219

Ray Teo 8/4



2219-T4  
#1 L = .3110"  
T = .1575"

500 lbs/in

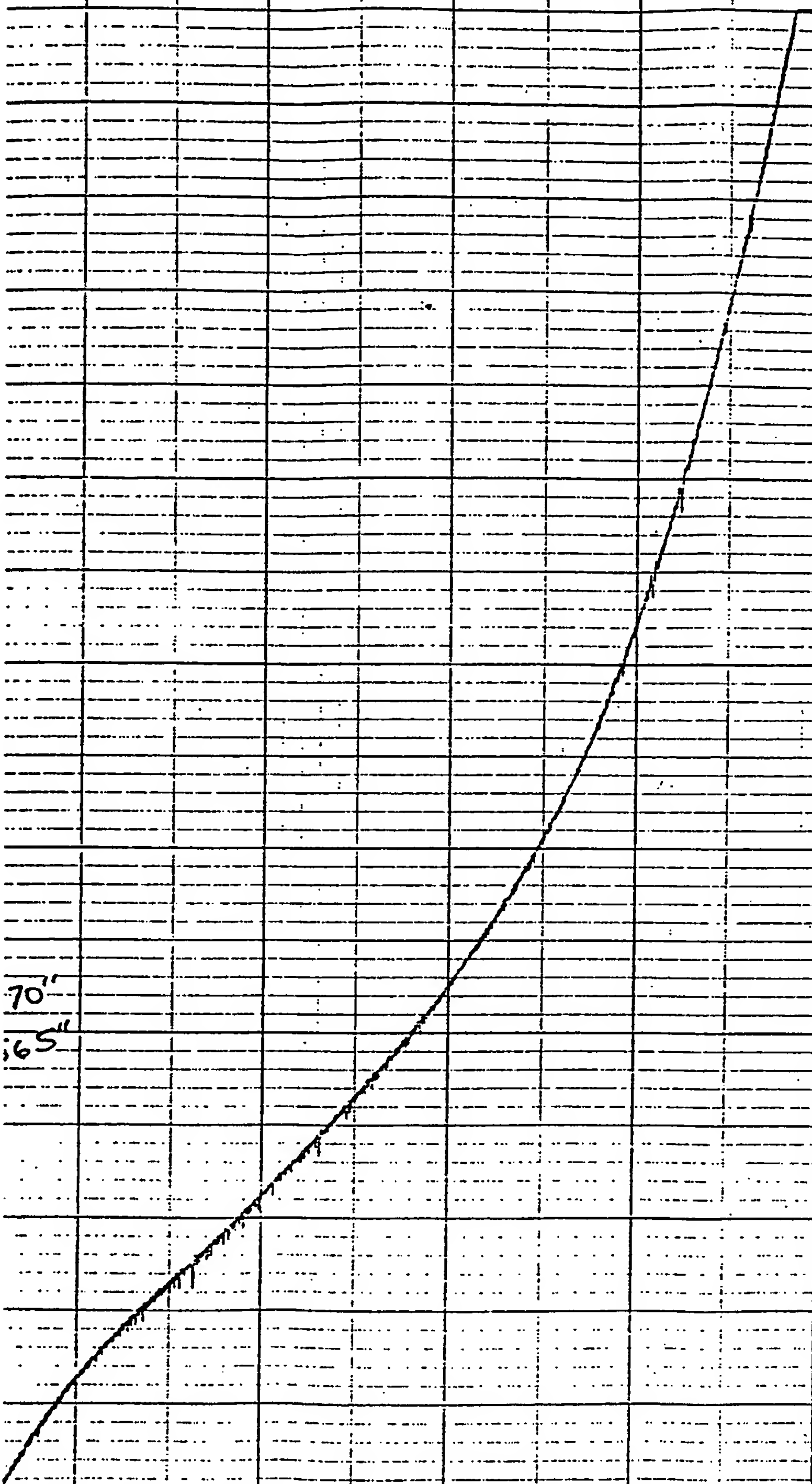
T  
L  
T

.025"/in

NO. NY 1101 5PT

- 14

70'  
65"



[REDACTED]  
[REDACTED]



5000

2219-T4

Ray Toosky

NO. XY 1101 SPH

CAD UNIT, INC.

2500

NO 1

2000

1500

NO

(2)

L = 3147

T = .1555

1000

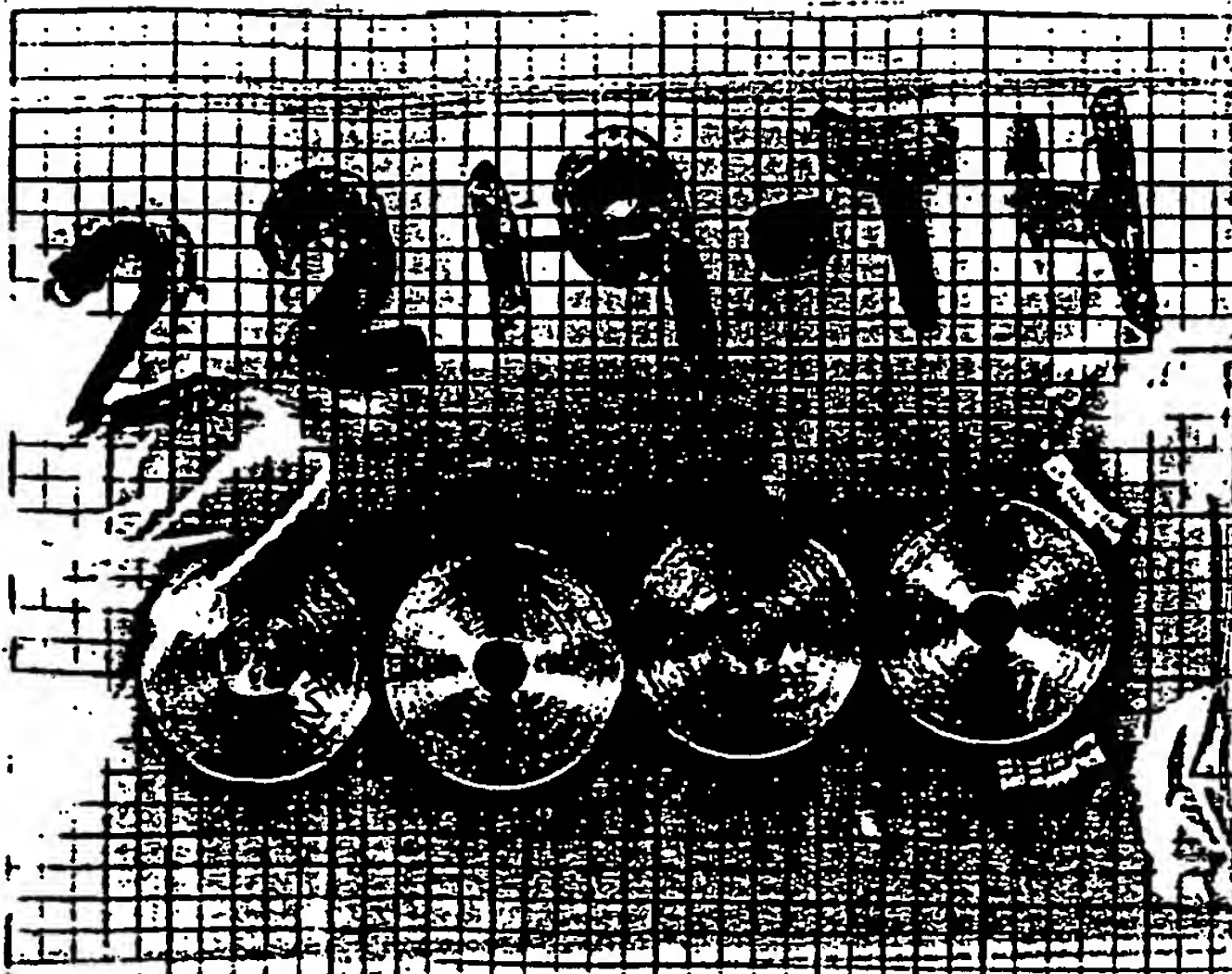
500

#1

2195-T4

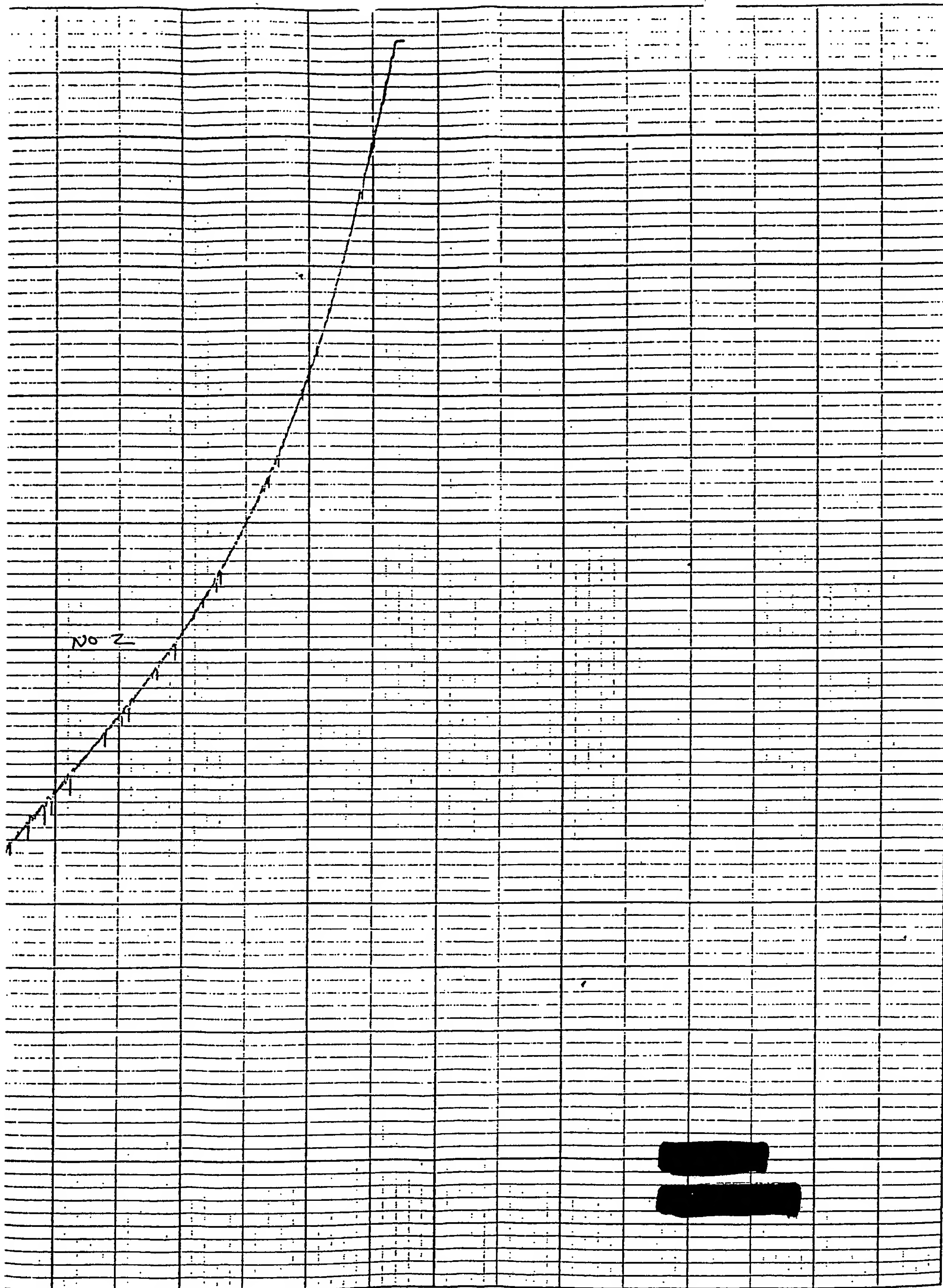
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2195-T4 .025



.025"

500lb.



.025"/in.

NO. XY 1101-SP4

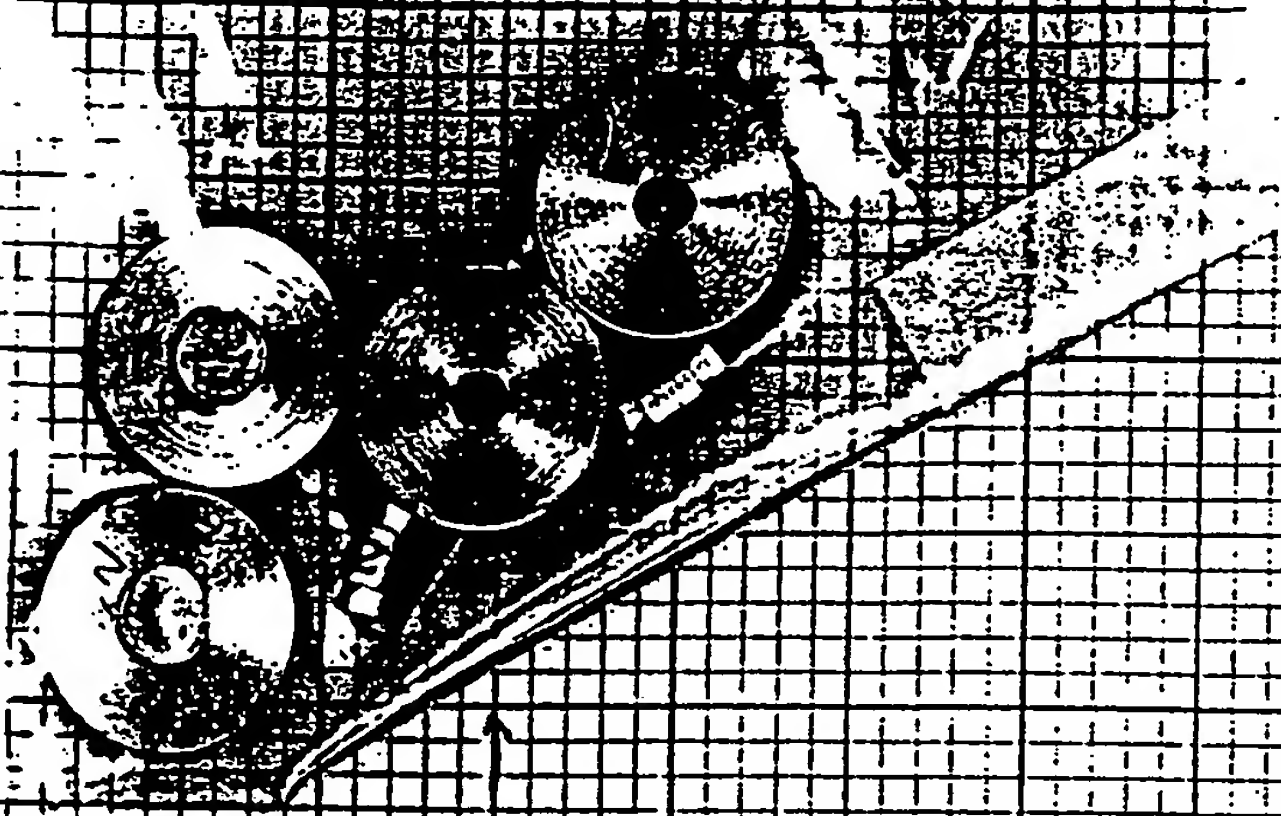
AD 1011, 100

500 lbs/in.

2219-T6

2219

2219



2219-T6  
L = 3175  
T = 1565

#2

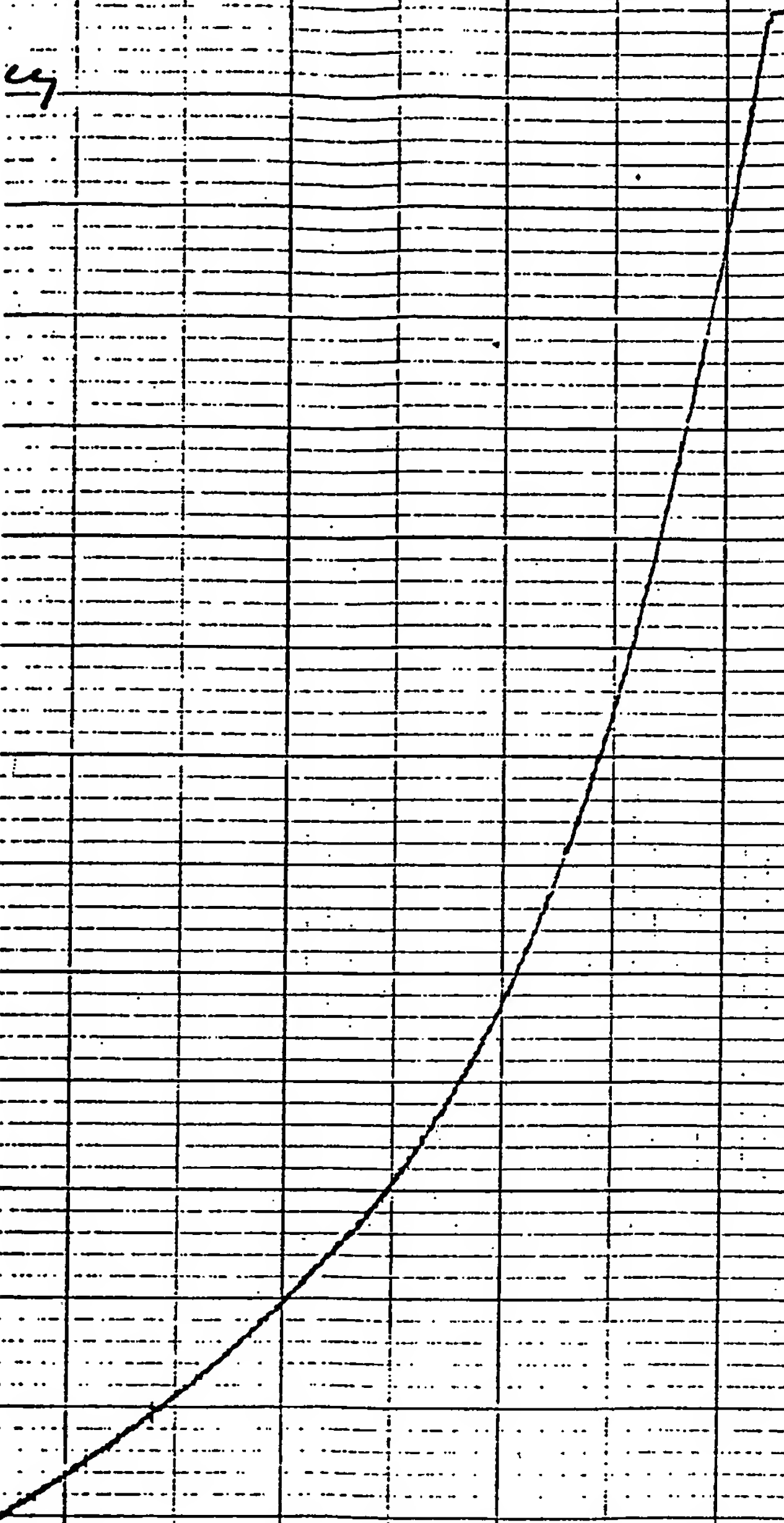
L = 3160  
T = 1560

.025"/in.



T6

47



[REDACTED]

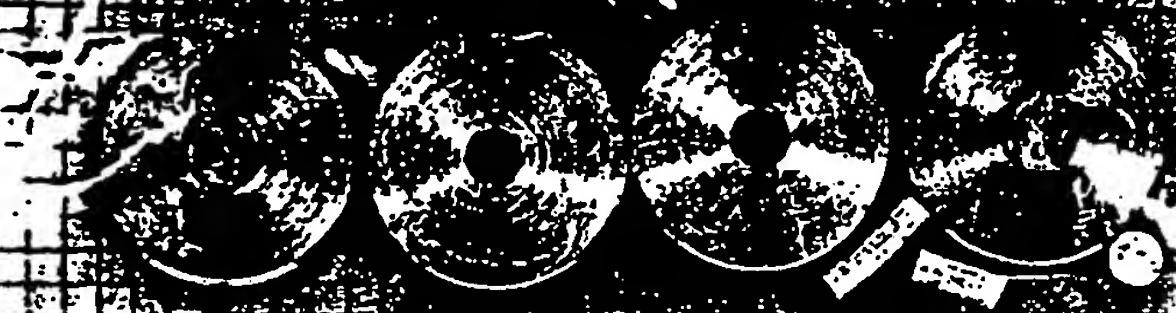
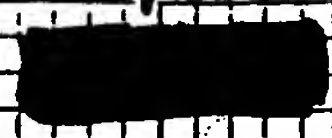


Scm

91

2195-T6

Ray Toosky



.025"

500lbs.

#1  
 $L = .3165'$   
 $T = .1545''$

#2  
 $L = .3150'$   
 $T = .1550''$

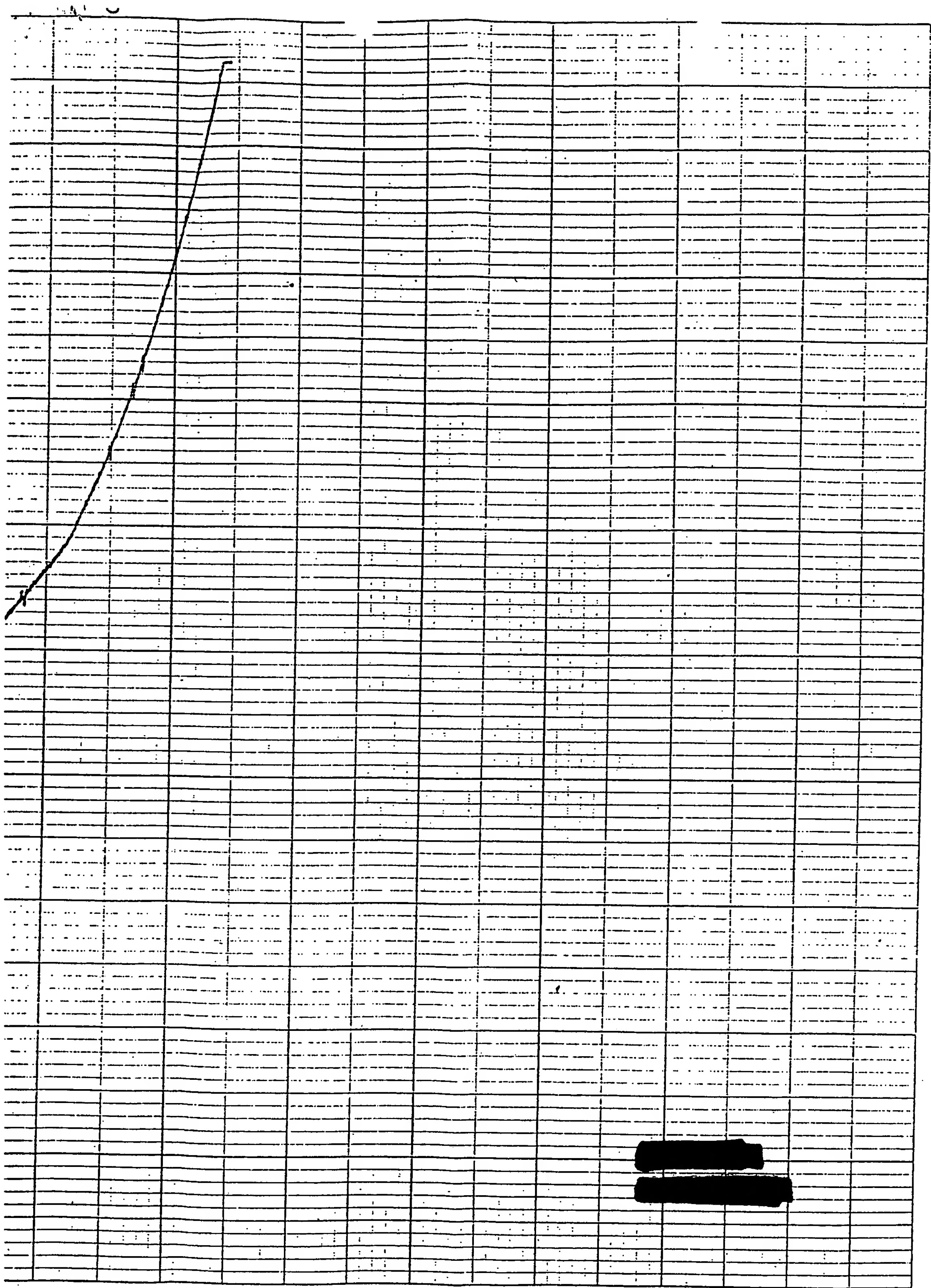
#1  
2195-T6

2195-T6

.025

HO. 3. 1101 SP2

3. 1101 SP2



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